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16. ABSTRACT

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A program was initiated by the Environmental Monitoring and Support Laboratory at Las Vegas to increase the number of locations monitoring sulfate and nitrate in the Western Energy Resource Development Area. This was accomplished primarily by augmenting the existing particulate sampling networks. This program has resulted in doubling the number of locations reporting sulfate and nitrate data and improving the geographic coverage. To evaluate and improve the quality of these data, a quality assurance program has also been established.

The sulfate-nitrate network resulting from this program was fully operational at the end of 1978. The data reported thus far indicate generally low values in this area. Typically, sulfate values are less than 6 micrograms per cubic meter ($\mu g/m^3$) and nitrate values are less than 3 $\mu g/m^3$. The data presented in this report cover the sampling period from January 1975 to December 1977.

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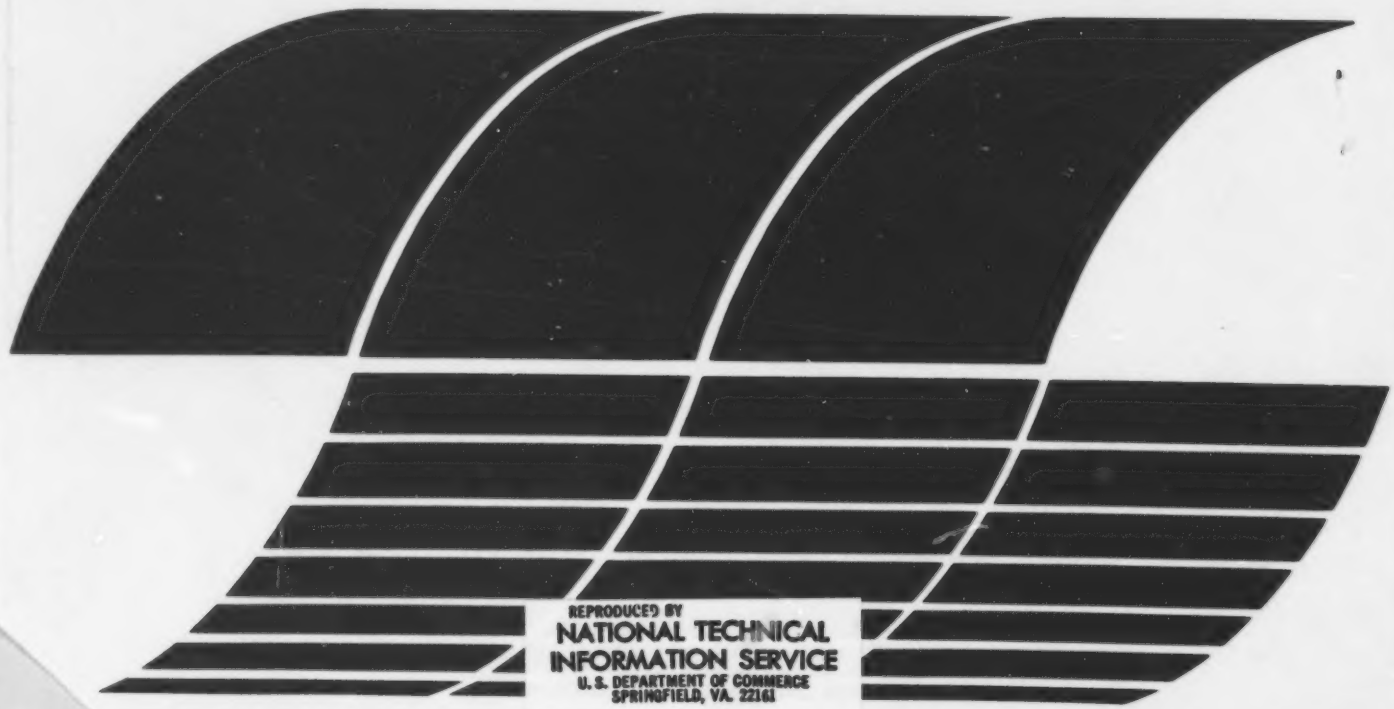

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March 1979

WESTERN ENERGY SULFATE/NITRATE MONITORING NETWORK PROGRESS REPORT

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FOREWORD

Protection of the environment requires effective regulatory actions which are based on sound technical and scientific information. This information must include the quantitative description and linking of pollutant sources, transport mechanisms, interactions, and resulting effects on man and his environment. Because of the complexities involved, assessment of specific pollutants in the environment requires a total systems approach which transcends the media of air, water, and land. The Environmental Monitoring and Support Laboratory-Las Vegas contributes to the formation and enchancement of a sound monitoring data base for exposure assessment through programs designed to:

- develop and optimize systems and strategies for monitoring pollutants and their impact on the environment
- demonstrate new monitoring systems and technologies by applying them to fulfill special monitoring needs of the Agency's operating programs

There is increasing evidence relating atmospheric sulfate and nitrate aerosols to health effects and visibility degradation. In many areas of the country, however, sulfates and nitrates are not routinely monitored. This report describes a program which has enriched the quantity and quality of the sulfate and nitrate data for an eight-state region in the western United States.

George B. Morgan
Director
Environmental Monitoring and
Support Laboratory

ABSTRACT

Interest in sulfate and nitrate aerosols has been on the increase largely due to studies relating sulfate and nitrate to health effects and visibility degradation and to changes in our national energy policy. The present and planned utilization of coal resources in the western United States will add to the sulfate-nitrate burden. However, little sulfate-nitrate data are available to establish a baseline and evaluate the impact of this development.

A program was initiated by the Environmental Monitoring and Support Laboratory at Las Vegas to increase the number of locations monitoring sulfate and nitrate in the Western Energy Resource Development Area. This was accomplished primarily by augmenting the existing particulate sampling networks. This program has resulted in doubling the number of locations reporting sulfate and nitrate data and improving the geographic coverage. To evaluate and improve the quality of these data, a quality assurance program has also been established.

The sulfate-nitrate network resulting from this program was fully operational at the end of 1978. The data reported thus far indicate generally low values in this area. Typically, sulfate values are less than 6 micrograms per cubic meter ($\mu g/m^3$) and nitrate values are less than 3 $\mu g/m^3$. The data presented in this report cover the sampling period from January 1975 to December 1977.

INTRODUCTION

Sulfate (SO_4) and nitrate (NO_3) compounds in the atmosphere originating from the combustion of coal in the western states are issues of increasing concern. Increased domestic energy production over the next 10 to 20 years will most certainly rely to a great extent on the development of the vast coal resources in the West. Approximately 37 percent of our total and 88 percent of our low sulfur coal reserves reside in this region. The development of these reserves and the accompanying proliferation of large (>300 megawatts) coal burning power generating facilities have raised concern over a number of air quality issues. The formation and regional transport of SO_4 and NO_3 compounds and their impact on health and welfare (including visibility values) is one issue of particular concern.

The potential impact of SO_4 and NO_3 production is threefold. Toxicological and epidemiological studies (EPA, 1975) suggest that sulfur transformation products are more likely than SO_2 alone to be responsible for many adverse health effects associated with sulfur oxides. Acid rain formation is of concern in terms of potential ecological and agricultural damage. Finally, and perhaps most importantly for the pristine West, the role of SO_4 and NO_3 in visibility reduction is of prime concern. It is estimated that under pristine conditions such as are found in the West, as little as a 4.5-$\mu g/m^3$ increase in fine particulate loading could result in as much as a 50-percent reduction in visual range (Charlson et al., 1978). In a region rich with scenic values, where visual range of over 100 kilometers is common, such an impact would be serious. The Clean Air Act of 1977 specifically declares as a national goal the prevention of any future, and the remedying of any existing impairment of visibility in mandatory Class I Federal areas where impairment results from man-made air pollution.

In view of these concerns, the Environmental Monitoring and Support Laboratory at Las Vegas (EMSL-LV) initiated a program to establish a SO_4/NO_3 baseline for the Western Energy Resource Development Area (WERDA), which encompasses the states of Arizona, New Mexico, Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota (Figure 1). The following discussion summarizes the status of that effort.

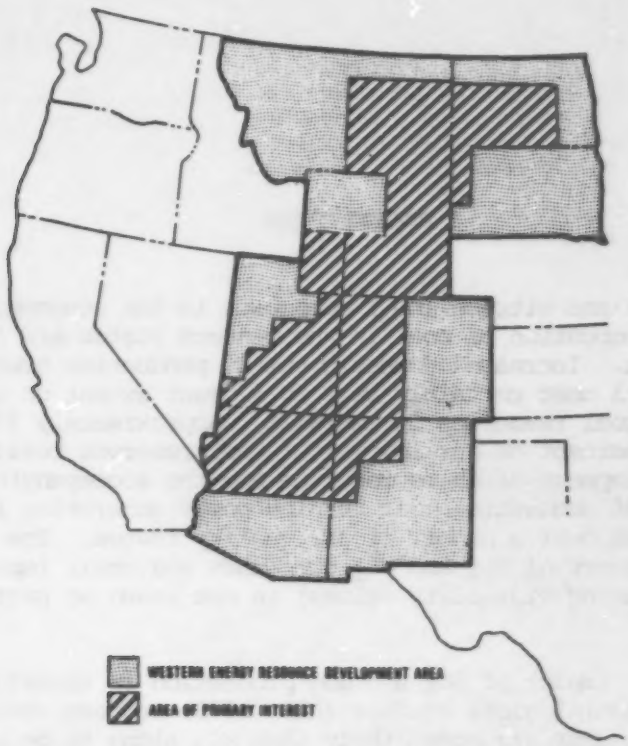

Figure 1. Western Energy Resource Development Area

CONCLUSIONS

The primary tasks of this program have been to improve the distribution and quality of sulfate and nitrate data available for the WERDA. Projections for 1978 show a substantial increase in sulfate-nitrate monitoring and improved geographic coverage. Through the Western Energy Quality Assurance program, data quality is being assessed. The results of this program indicate an improvement in data quality. Finally, data reported show some detectable regional variations and a strong contrast with data reported for the eastern United States.

NETWORK DEVELOPMENT

EMSL-LV is engaged in a multi-year program which began in 1975 and was designed to evaluate the air quality impacts of energy-related developments in the WERDA. The primary objectives of the program are to establish an energy-related air quality baseline, evaluate air quality trends, assess the impacts of specific energy-related development activities, and predict the impact of proposed energy developments.

Early in this program particulate SO_4 and NO_3 were recognized as pollutants of major concern. A survey of SO_4 and NO_3 data collected in the WERDA during 1975 was conducted. The results of this survey are presented in Column 1 of Table 1. In terms of the numbers of reporting stations, Arizona and North Dakota were the only states which had a significant level of SO_4/NO_3 monitoring activity. A map showing the distribution of the SO_4/NO_3 monitoring stations (Figure 2) illustrates the poor geographic coverage provided by the 103 stations reporting SO_4/NO_3 data in 1975. Based on this type of data survey it was apparent that a program was required to increase the amount of SO_4/NO_3 data gathered.

Such a program was initiated early in 1976. Since there was an abundance of high volume particulate samplers being operated by a variety of groups throughout WERDA, it was not necessary to establish new sampling locations. Filter samples which were being gravimetrically analyzed for total suspended particulates could also be analyzed for SO_4/NO_3. State air pollution control agencies operate the majority of particulate samplers in the WERDA. The EMSL-LV also operates a large high volume particulate sampling network in the southwest through a contract with the Ute Research Laboratory (URL) (see Figure 3).

With the exception of Arizona and New Mexico, the states which comprise the WERDA are in EPA Region 8. Representatives of Region 8 were contacted concerning augmentation of the state operated particulate sampling networks for SO_4/NO_3 analysis. The regional representatives suggested that the states of Montana, Colorado, North Dakota, and South Dakota could perform this analysis on filter samples from their networks with a modest increase in their grant funding. The states of Utah and Wyoming would require considerable additional support to perform SO_4/NO_3 analysis, but would be willing to send samples elsewhere for that analysis.

TABLE 1. NUMBER OF STATIONS REPORTING

	Sulfate				Nitrate			
	75	76	77	Projected 78	75	76	77	Projecte 78
Arizona	56	43	42	61	19	14	17	26
Colorado	3	3	31	34	2	1	31	33
Montana	4	8	5	19	4	4	0	14
New Mexico	1	3	5	5	1	1	5	5
North Dakota	29	36	36	36	30	37	37	37
South Dakota	2	2	0	6	2	2	0	6
Utah	5	6	8	18	5	6	8	18
Wyoming	3	2	0	13	3	2	0	13
TOTAL	103	103	127	192	66	67	98	152

*Based on data in the National Aerometric Data Base on May 4, 1978, a station is counted if it reports data during any portion of the year.

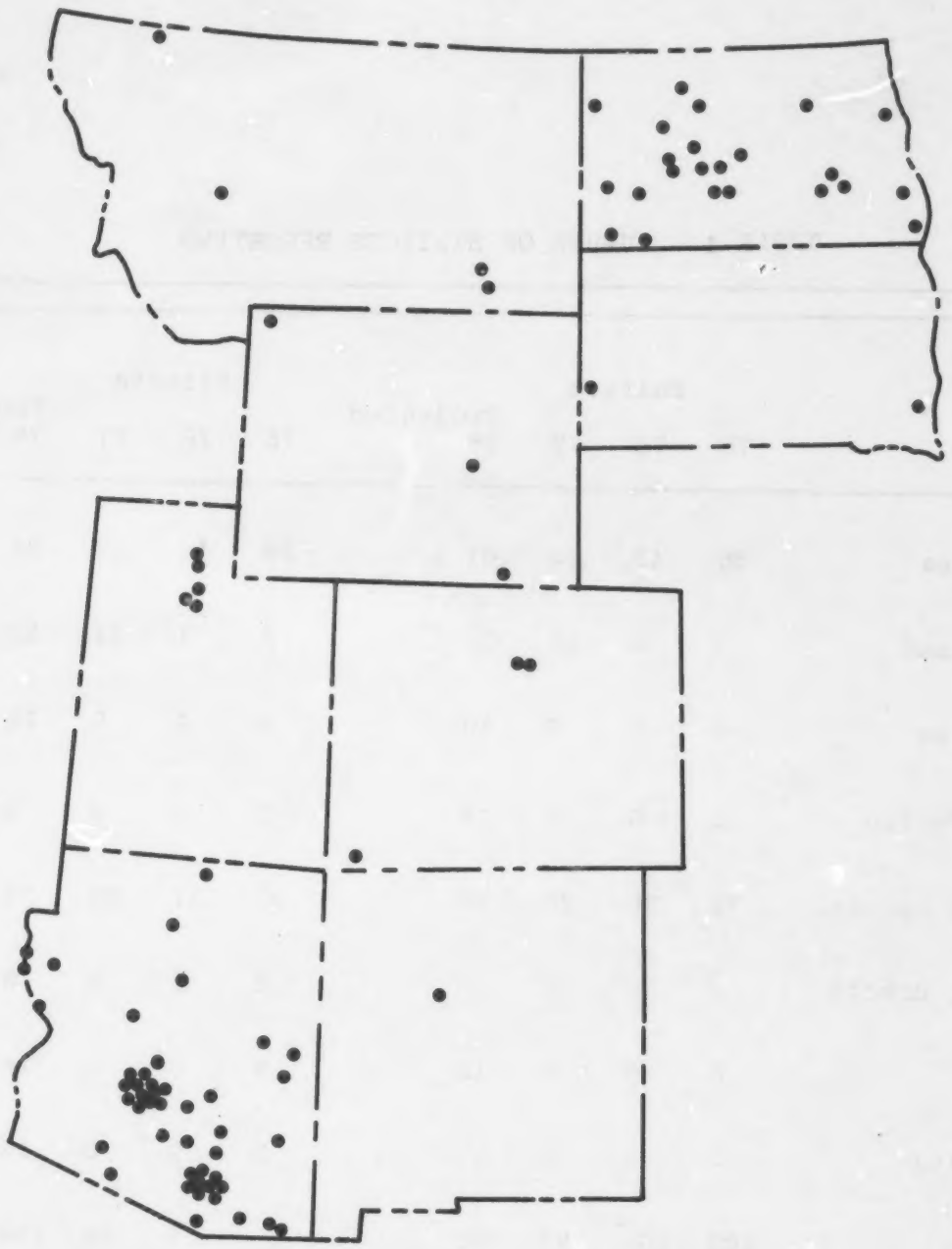

Figure 2. Sulfate-nitrate sampling in the WERDA, 1975

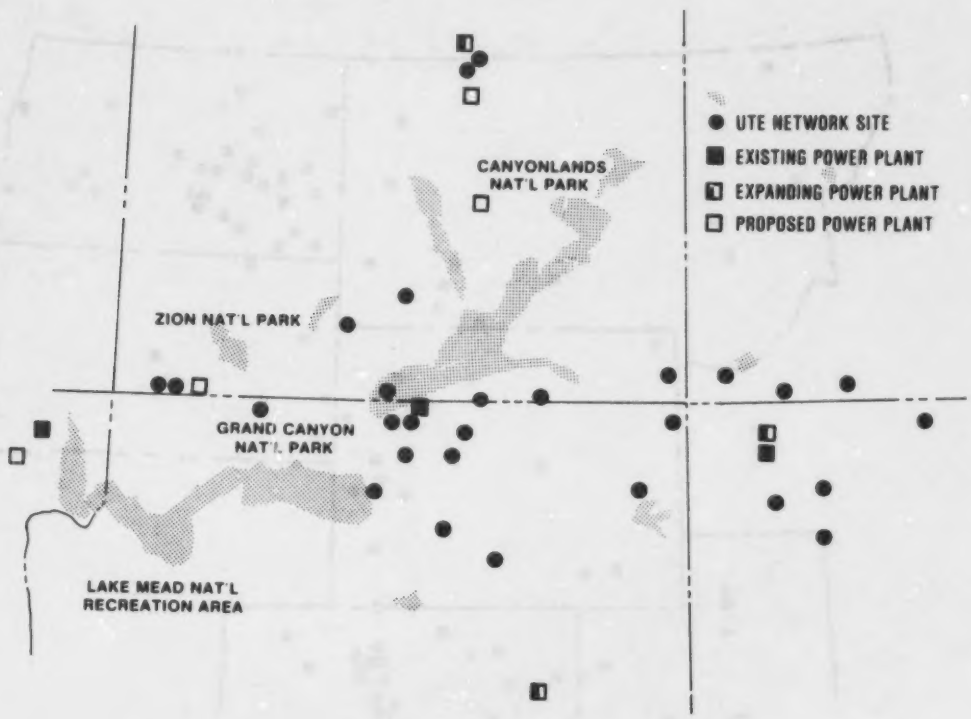

Figure 3. Ute Research Laboratory Hi-Vol sampler network

Funds were transferred in the summer of 1976 from the EMSL-LV to Region 8 so that the state grants to Montana, Colorado, North Dakota, and South Dakota could be increased to support SO_4/NO_3 analysis. Augmentation of the URL network for SO_4/NO_3 analysis was accomplished by expanding their scope of work and furnishing them with the equipment and training required. Arrangements were made for samples to be sent from the states of Utah and Wyoming to the URL for analysis.

Analysis for SO_4/NO_3 by a number of laboratories was delayed. The majority of the program outlined above was operational by June, 1978. The remainder of the laboratories were performing SO_4/NO_3 analysis by the end of 1978. The effects of this program are to nearly double the number of locations reporting SO_4/NO_3 data (see Table 1) and to provide much better geographic coverage of WERDA (see Figure 4).

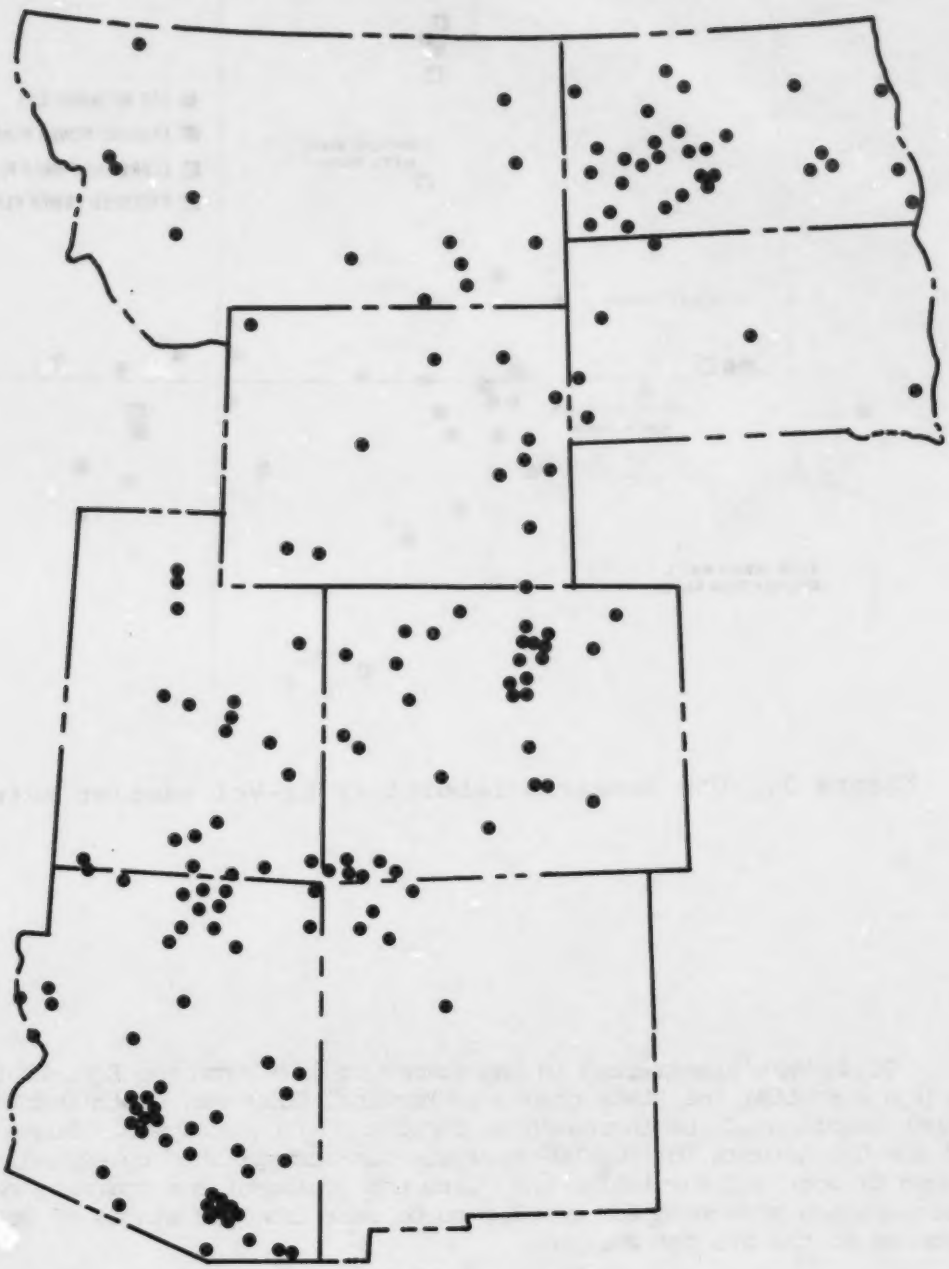

Figure 4. Sulfate-nitrate sampling in the WFRDA, 1978

QUALITY ASSURANCE

In order to compare the data collected by the various laboratories in the WERDA, the quality of the various data sets must be known. A quality assurance program was developed to evaluate the sample collection and analysis performed by each laboratory and to provide technical assistance in areas that would improve data quality. A portion of this program directly relates to the quality of the sulfate and nitrate data. The participants in this program are Arizona, Colorado, Montana, New Mexico, North Dakota, Northern Testing Laboratory and Ute Research Laboratory.

During the last quarter of 1976, Rockwell International under a contract monitored by the Quality Assurance Branch of the Environmental Monitoring and Support Laboratory at Research Triangle Park (EMSL-RTP), began a series of interlaboratory cross comparisons. Among these comparisons were checks of high volume sampler (Hi-Vol) flow calibrations and sulfate and nitrate analysis. In order to be consistent with the quality assurance program, an anonymous laboratory code is used to report the results of the various audits for the laboratories. Only the results of Rockwell comparisons with EMSL-RTP are identified in the report.

The first portion of the comparisons affecting the data quality is the high volume sampler flow-calibration performance check. A calibration kit containing a series of "unknown" orifice plates is sent to the participating laboratories. With this equipment mounted on a Hi-Vol sampler, measurements of the pressure drop across the various plates and the flow using the laboratory's flow meter are made. These values and the ambient pressure and temperature are reported to Rockwell International. The flows are then computed and a report summarizing the results of all the participating laboratories is compiled.

In order to evaluate the analysis capabilities of each participating laboratory a set of four-to-six filter strips spiked with varying amounts of sulfate and nitrate ions is sent to each laboratory on a quarterly basis. Each laboratory analyzes the filter samples and reports the results to Rockwell International. Rockwell analyzes a minimum of ten filter sets to establish the sample values using the methylthymol blue procedure for sulfate and the copperized cadmium reduction method for nitrate. The results of the individual laboratory analyses are compared with Rockwell's results and a summary report is compiled.

The results of the Hi-Vol flow calibration and the sulfate and nitrate analyses are summarized in Tables 2 and 3. These tables give the mean

TABLE 2. HI-VOL FLOW CALIBRATION - PERCENT DIFFERENCE

Lab	1st Half 1977 Mean	1st Half 1977 SD	2nd Half 1977 Mean	2nd Half 1977 SD
A	- 3.4	10.1	0.6	3.2
B	- 9.5	3.2	- 5.6	6.1
C	19.8	9.3	2.4	12.2
D	- 2.2	3.2	- 3.4	2.8
E	-11.7	2.0	0.1	1.8
F	1.9	1.7	- 4.6	0.9
G	- 1.5	2.2	10.4	6.2

TABLE 3. QUALITY ASSURANCE AUDITS - PERCENT DIFFERENCE

SULFATE

Lab	1976 4th Quarter Mean	1976 4th Quarter SD	1977 1st Quarter Mean	1977 1st Quarter SD	1977 2nd Quarter Mean	1977 2nd Quarter SD	1977 3rd Quarter Mean	1977 3rd Quarter SD	1977 4th Quarter Mean	1977 4th Quarter SD
A	119.2	123.4	12.3	8.5	131.5	31.3	3.9	13.8	4.1	10.0
B	- 9.3	12.4	- 5.0	3.9	- 25.9	18.5	9.9	4.6	- 1.9	13.3
C	- 5.6	21.4	9.0	5.1	- 0.5	12.6	- 20.8	31.1	- 22.3	45.6
D	34.7	54.1	12.6	14.3	- 14.6	19.2	- 19.0	33.7	26.5	66.7
E					7.3	4.5	6.8	3.4	13.3	18.5
F	53.5	63.0	2.5	7.9	10.8	9.7	3.2	3.2	20.3	52.4
G	- 16.2	18.0	5.9	3.7	- 13.3	9.5	- 18.7	36.5	- 18.9	29.2
EMSL-RTP	- 0.2	2.0	3.4	2.3	- 1.2	8.3	2.9	3.5		

NITRATE

Lab	1976 4th Quarter Mean	1976 4th Quarter SD	1977 1st Quarter Mean	1977 1st Quarter SD	1977 2nd Quarter Mean	1977 2nd Quarter SD	1977 3rd Quarter Mean	1977 3rd Quarter SD	1977 4th Quarter Mean	1977 4th Quarter SD
A	5885.0	7835.2	31.7	23.9	105.1	6.5	22.2	7.4	12.8	16.2
B	14.5	11.6	- 11.2	4.3	- 8.6	10.8	15.7	4.6	21.9	12.9
C	- 0.9	6.0	- 0.1	22.2	157.3	350.2	4.4	12.3	- 41.8	6.2
D	35.7	42.0	20.8	13.1	5.8	17.0	- 16.5	10.2	9.5	6.0
E					29.4	6.3	0.1	8.6	5.9	8.4
F	63.1	88.8	- 11.3	4.5	- 18.6	9.0	6.7	11.0	- 0.5	17.4
EMSL-RTP	1.2	1.0	9.3	4.1	- 7.7	2.4	1.9	1.9		

and standard deviation (SD) of the percent difference between the results of Rockwell and the individual laboratories. Additional information is provided in the annual report prepared for EMSL-RTP by Rockwell.

In general, the quality assurance program results indicate an improvement with time. The results of the Hi-Vol flow calibration audits, presented in Table 2, show a decrease in the percent difference. The majority of the laboratories show a mean percent difference of 5% or less for the second half of 1977. The sulfate and nitrate results, presented in Table 3, show a similar improving trend, with percent differences of approximately 25% or less for the fourth quarter of 1977. The extreme values in Table 3, which may indicate serious problems with analysis procedures, appear to have been eliminated during the course of this program.

DATA ANALYSIS

The data reported to the National Aerometric Data Base for the WERDA for 1975 through the present are presented in Table 4. These data are the result of a retrieval made on May 4, 1978, and provide the basis for the analysis presented in this report. Further station information is provided in Appendix A. It should be noted that this data base is a dynamic system and modifications can occur at anytime. Therefore, retrievals made at other times may result in different quarterly means and different stations reporting.

In computing the quarterly means, the retrieval program used half the assumed minimum detection limits for all reported values less than that detection limit 0.5 $\mu g/m^3$ for sulfate and 0.05 $\mu g/m^3$ for nitrate. Mean values are then rounded to the nearest 1 $\mu g/m^3$ for sulfate and 0.1 $\mu g/m^3$ for nitrate.

While analyzing the data for North Dakota, a possible error was detected. Approximately 20 of the state-operated stations reported zero values for July through September 1975 and higher values before and after this period. Nine additional stations reported zero values from September 1975 through June 1976 with higher values before and after this period. This was reported to EPA Region 8 and data correction is pending further investigation. Since data values reported in this area are generally less than 3 $\mu g/m^3$, these data should have little effect on the analysis presented in this report.

As mentioned in earlier sections, the density and geographic distribution of stations reporting sulfate and nitrate data in 1975 are inadequate for detailed regional analysis and trend assessment. Only Arizona and North Dakota reported enough data to draw regional conclusions. Since 1975, the amount and coverage of these data have shown continuous improvement. Even so, significant gaps still exist in the 1977 data. Until late 1976, the quality and intercomparibility of the data reported were unknown.

To overcome the data deficiencies and provide an analysis on a regional scale, a series of assumptions were required. It was assumed that the temporal variability of the data could be ignored, thereby allowing mixing of 1975 data with 1976 and 1977 data. Quarterly means were all weighted equally, regardless of how many samples were included in the mean. Finally, the quality and intercomparability of the data were assumed to be adequate for the purpose of this analysis.

Given these assumptions, the means for each quarter were displayed in a series of maps. These maps were used to develop a composite map of the mean values based on all available data. A series of arbitrary ranges were then selected to classify the data. Areas lacking data were left blank, while data areas were shaded to indicate the data range. The results of this analysis are presented in Figures 5 and 6.

The sulfate composite map (Figure 5) shows a number of regional characteristics. The North Dakota area reports values from 1 to 3 $\mu g/m^3$ with small areas (probably related to local sources) reporting in the 3 to 6 $\mu g/m^3$ range. Data in the 1 to 3 $\mu g/m^3$ range are also reported in northern Arizona, southern Utah, northwestern New Mexico, and southeastern Colorado. In contrast, the remainder of Colorado reports large areas in the 3 to 6 $\mu g/m^3$ range and southern Arizona reports values from 3 $\mu g/m^3$ to greater than 15 $\mu g/m^3$. With the exception of southern Arizona the region as a whole lies in the range from 1 to 6 $\mu g/m^3$.

The sulfate composite map also shows the significance of point sources. The Salt Lake City area in northern Utah is a dramatic example. A single point source is the probable cause of the greater than 15 $\mu g/m^3$ sulfate area on the western edge of Salt Lake City. This effect appears to drop off rapidly to the 3 to 6 $\mu g/m^3$ range. Similarly, each of the high sulfate areas in southern Arizona can be linked to large point sources.

The sulfate data for the WERDA sharply contrast values reported for the eastern United States. In 1975 Mitre (Greeley et al., 1975) reported mean sulfate values in the West ranging from 2.6 $\mu g/m^3$ in rural areas to 6 $\mu g/m^3$ in urban areas. With the exception of the point source areas already pointed out, sulfate in the WERDA is consistently below the 6 $\mu g/m^3$ figure. In contrast, Mitre reported eastern mean values ranging from 8 $\mu g/m^3$ in non-urban areas to 13 $\mu g/m^3$ in urban areas.

The nitrate data, presented in Figure 6, show somewhat poorer coverage than the sulfate data. Mean values range from 1 $\mu g/m^3$ to 5 $\mu g/m^3$ with only one area reporting greater than 5 $\mu g/m^3$. The composite map also shows greater variability than was seen in the sulfate area. As one might expect, major urban areas report higher nitrate values and show greater variability over small geographic areas. Rural areas, on the other hand, report lower and more uniform values. Although the categories used to classify nitrate data were small, it is likely that this urban variability is real and source-related. Aside from the high urban values, no regional contrasts are apparent.

The quality and intercomparability of the data deserve some further consideration. It should be noted that data comparison within an area controlled by a single agency may not be drastically affected by the question of data quality. All data values should be subject to the same quality control and should result in long term means that can be compared with other means for the laboratory. However, comparison of different laboratory regions could have some definite problems. If today's quality assurance program can be considered representative of the past, then errors of 20%

TABLE 4. DATA REPORTED FOR THE WERDA, 1975

SULFATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	ARIZONA													
1	Ajo	9.0	5.0	12.0*	9.0	8.0	6.0	9.0	6.0	6.0				X
2	Teec Nos Pos									3.0*	2.0	2.0	2.0*	X
3	Redrock									2.0*	3.0	2.0	3.0*	X
4	Eager	3.0	3.0	5.0	5.0*		1.0*							X
5	Casa Grande	6.0	4.0	6.0	8.0*									X
6	Chandler	5.0												X
7a	Douglas			11.0	11.0*	11.0*				9.0*				X
7b	Douglas	13.0	9.0	11.0	9.0	8.0*	7.0	8.0	6.0*	5.0				X
7c	Douglas	6.0*	4.0	9.0	6.0	6.0	4.0	7.0*	5.0*					X
8	Paul Spur	5.0	4.0	11.0	11.0	8.0	5.0	7.0	5.0	7.0*				X
9	Page	2.0	3.0	5.0	5.0*									X
10	Kaibeto									2.0*	2.0	2.0	2.0*	X
11	Coppermine									2.0	3.0	5.0*	3.0*	X
12	Bodaway									2.0*	1.0*	3.0*	3.0*	X
13	Tsai Skizzi									2.0*	3.0	2.0		X
14	Tuba City									1.0*	2.0	2.0	2.0*	X
15	Flagstaff	0.0	2.0	3.0	4.0*		2.0*							X
16a	Hayden	17.0	7.0	12.0	15.0	10.0	8.0	11.0	13.0	11.0				X
16b	Hayden	20.0*								10.0*				X
17a	Miami	19.0*	7.0	9.0	11.0	8.0	5.0			12.0				X
17b	Miami	3.0*	2.0	8.0	4.0	4.0	4.0	6.0	6.0	5.0	4.0			X
18	Glendale	0.0*	2.0*	2.0	2.0	0.0	1.0	2.0*	1.0					X
19	Grand Canyon National Park	25.0	10.0	15.0	17.0	11.0	9.0	9.0	14.0	12.0				X
20	Morenci	3.0	2.0	5.0	8.0									X
21	Kingman	2.0	1.0	5.0	3.0	3.0	3.0	4.0						X
22	Carefree	4.0	2.0	7.0	7.0	4.0	3.0	4.0						X
23	St. Johns	5.0	2.0	6.0	8.0	5.0	3.0	7.0						X
24	Guadalupe	3.0	2.0											X
25	Litchfield	3.0	1.0	5.0	4.0	2.0	3.0	4.0	4.0	3.0	3.0			X
26	Mesa	3.0	4.0	7.0	5.0*									X
27	Davis Dam										2.0	4.0*	2.0*	X
28	Moccasin	0.0	3.0	4.0	3.0*									X
29	Lake Havasu		7.0	14.0	14.0*									X
30	Mineral Park								2.0*	2.0	3.0	2.0*	5.0*	X
31	Bacabi													

(Continued)

TABLE 4. (CONTINUED)

SULFATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	ARIZONA (cont.)													
32	Show Low	2.0	2.0	5.0	5.0*									X
33a	Nogales	10.0*												
33b	Nogales					16.0*								X
34	Paradise Valley	3.0												
35	Phoenix	4.0	2.0	5.0	5.0	4.0	3.0	5.0	7.0	4.0*	7.0			X
36	Lee's Ferry									3.0*	3.0	2.0*		X
37a	Phoenix	2.0	1.0	6.0	4.0	4.0	4.0	4.0	6.0	3.0	3.0			X
37b	Phoenix	7.0*												
37c	Phoenix	6.0	4.0	7.0	7.0	5.0	3.0	6.0	6.0	19.0				X
38a	Phoenix	5.0												
38b	Phoenix	2.0	1.0	6.0	4.0	3.0	3.0	5.0	6.0	4.0	3.0			X
39	Organ Pipe National Monument	3.0	2.0	3.0	5.0	5.0	2.0	2.0	5.0	4.0				X
40	Green Valley				6.0*	3.0		4.0	5.0*	4.0	3.0			X
41	Rillito	5.0	3.0	6.0	5.0*									X
42	Rillito	4.0	2.0											
43	Tucson				6.0	5.0		4.0	5.0	5.0	4.0			X
44a	Twin Buttes	10.0*	27.0	22.0	19.0	16.0	27.0	29.0	10.0	10.0				X
44b	Twin Buttes						33.0	40.0	13.0	14.0				X
45	Florence	6.0	4.0	11.0	28.0	2.0*	3.0	5.0	7.0	7.0				X
46	San Manuel	12.0	10.0	10.0	11.0	8.0	7.0	11.0	8.0	8.0				X
47	Prescott	1.0	2.0	4.0	4.0*									X
48	Safford	7.0	4.0	7.0	7.0	5.0	4.0	8.0	7.0*	5.0				X
49a	Scottsdale	2.0	2.0	9.0	5.0	3.0	3.0	6.0	5.0	3.0	4.0			X
49b	Scottsdale	3.0	1.0	7.0	5.0	3.0	3.0	4.0	5.0	3.0	4.0			X
50	Sierra Vista	4.0	2.0	6.0	7.0	5.0	3.0	8.0	7.0	5.0				X
51	South Tucson				3.0*		3.0*		5.0	8.0*				X
52	Sun City	3.0												
53	Superior	7.0	4.0	8.0	8.0	4.0	5.0	6.0*	7.0	7.0				X
54a	Tucson	3.0	2.0	6.0	5.0	3.0	3.0	4.0	3.0					X
54b	Tucson				5.0	4.0		4.0	4.0	5.0	4.0			X
54c	Tucson								3.0*	5.0	4.0			X
54d	Tucson				6.0	5.0		4.0	4.0	5.0	4.0			X
55a	Tucson				6.0	4.0		4.0	4.0	5.0	4.0			X
55b	Tucson				5.0	4.0		5.0	4.0	6.0	3.0			X
56	Tucson				6.0	4.0		4.0	4.0*					X

(Continued)

TABLE 4. (CONTINUED)

SULFATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	COLORADO													
1	Red Mesa									2.0*	2.0	3.0*		X
2	Ignacio										3.0	2.0*		X
3	Towaoc								2.0*	1.0*	2.0	3.0*	2.0*	X
4	Adams City												6.0	X
5	Sand Dunes N.M.												2.0	X
6	Brush												4.0	X
7	Colorado Springs												5.0	X
8	Cortez												2.0	X
9	Craig												5.0	X
10	Delta												7.0	X
11	Denver		3.0	3.0	4.0*	4.0	2.0	3.0	3.0					X
12	Denver	4.0*	4.0	3.0	3.0									
13	Denver												2.0	X
14	Denver												4.0	X
15	Fort Collins												3.0	X
16	Glenwood Springs												4.0	X
17	Grand Junction												5.0	X
18	Greeley												3.0*	X
19	Gunnison												5.0	X
20	Walden												2.0	X
21	La Junta												4.0	X
22	Loveland												5.0	X
23	Mesa Verde N.P.	1.0*	1.0*	2.0	1.0	1.0	1.0*	1.0	1.0					X
24	Mesa Verde N.P.												3.0	X
25	Pueblo												5.0	X
26	Pueblo												4.0	X
27	Wesker												5.0	X
28	Rangley												4.0*	X
29	Steamboat Springs												6.0	X
30	Sterling												4.0	X
31	Johnstown												3.0	X
32	La Salle												5.0	X
33	Platteville												4.0	X
34	Erie												4.0	X
35	Loveland													X

(Continued)

TABLE 4. (CONTINUED)

SULFATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	MONTANA													
1	Missoula					5.0	5.0	5.0	7.0			4.0*	8.0	X
2	Missoula					4.0	3.0	6.0	9.0			5.0*	7.0	X
3	Missoula											4.0*	3.0	X
4	Missoula											3.0*	5.0	X
5	Missoula							4.0*	6.0					
6	Frenchtown					5.0	3.0	5.0	7.0			7.0*		X
7	Glacier N.P.	3.0*	1.0*	1.0	1.0	2.0	1.0	1.0*	1.0					X
8	Helena	4.0*	1.0*	3.0	2.0			3.0	2.0					X
9	Ft. Howes	2.0*	1.0*	1.0	0.0			1.0	0.0					X
10	Ashland	4.0	3.0*	2.0*	1.0*	2.0	1.0	1.0	2.0					X
11	Decker													X
12	Billings													X
13	Butte													X
14	Ekalaka													X
15	Lindsay													X
16	Lindsay													X
17	Helena													X
18	Helena													X
19	Poplar													X
20	Colstrip													X
	NEW MEXICO													
1	Dulce									2.0*	2.0	2.0	1.0*	X
2	Huerfano								5.0*	3.0*	3.0*	3.0*	3.0*	X
3	Chaco Canyon N.M.									2.0*	2.0	2.0*	3.0*	X
4	Burnham								4.0*	2.0*	3.0*	2.0*		X
5	Albuquerque	2.0*	1.0	4.0*	1.0*	2.0*	2.0	3.0*	2.0	2.0*	3.0*			X
	NORTH DAKOTA													
1a	Maryvale	5.0	2.0	0.0*	3.0	5.0	6.0*							
1b	Valley City							3.0	3.0		2.0	4.0	1.0	X
2	Medora			0.0*	0.0	0.0	0.0	2.0	2.0		2.0	3.0	2.0	X
3a	Bismarck	5.0	3.0	1.0	2.0	3.0	3.0	3.0	4.0		3.0	4.0	3.0	X
4	Bowman			0.0*	0.0	0.0	0.0	2.0	1.0		1.0	3.0	1.0	X
5	Bismarck										4.0	4.0	2.0	X
6a	Fargo	3.0	2.0	0.0	2.0	3.0	3.0*	3.0	3.0		3.0	4.0	2.0	X
6b	Fargo	7.0	3.0	1.0	3.0	9.0	6.0*	3.0	6.0		4.0	4.0	5.0	X

(Continued)

TABLE 4. (CONTINUED)

SULFATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	NORTH DAKOTA (cont.)													
6c	Fargo	4.0	3.0	0.0	3.0	5.0	4.0*	3.0	4.0		3.0	5.0	3.0	X
7	Devil's Lake	4.0	3.0	0.0	3.0	3.0	2.0*	2.0	3.0		2.0		2.0	X
8a	Dickinson	2.0	2.0	0.0	3.0	3.0	3.0*	3.0	2.0		2.0	3.0	2.0	X
8b	Dickinson				1.0*	2.0	3.0*	3.0	3.0		2.0	3.0	1.0	X
9	Mandaree							5.0*	4.0		3.0	3.0	2.0	X
10	Halliday								2.0		2.0	2.0	2.0	X
11a	Grand Forks	6.0	3.0	0.0	4.0*	9.0	3.0*	3.0	6.0		3.0	3.0	3.0	X
11b	Grand Forks		4.0	0.0	6.0	10.0	5.0*	4.0	8.0		6.0	5.0	5.0	X
12	Glen Ullin							3.0*	2.0		2.0	3.0	1.0	X
13	Mott			0.0*	0.0	0.0	0.0	1.0	1.0		2.0	4.0	1.0	X
14	New England							1.0*	1.0		2.0	3.0	0.0	X
15a	Jamestown	3.0	2.0	0.0	3.0	4.0	3.0*	3.0	4.0		2.0	3.0	1.0	X
15b	Jamestown	3.0	2.0	0.0	2.0	3.0	1.0*	3.0	2.0		3.0	4.0	2.0	X
16	Grassy Butte							2.0*	1.0		2.0	4.0	1.0	X
17	Garrison			0.0*	0.0	0.0	0.0	3.0	3.0		2.0	3.0	2.0	X
18	Washburn			0.0*	0.0	0.0	0.0	3.0	3.0		3.0	4.0	1.0	X
19	Mandan	3.0	3.0	1.0	3.0	3.0	4.0	3.0	4.0		4.0	3.0	2.0	X
20	Beulah	5.0	4.0	1.0	7.0	8.0	7.0	3.0	5.0		3.0	3.0	2.0	X
21	Beulah	4.0	3.0	1.0	2.0		2.0	2.0	2.0		2.0	3.0	1.0	X
22	Minot	2.0	0.0*	0.0*	3.0	4.0*		1.0*			2.0	2.0*	2.0	X
23	New Salem							2.0*	2.0		2.0	3.0	1.0	X
24	Parshall			0.0*	0.0	0.0	0.0	3.0	5.0		2.0	3.0	1.0	X
25	Stanton			0.0*	0.0	0.0	0.0	3.0	2.0		3.0	3.0	2.0	X
26a	McClusky			0.0*	0.0	0.0	0.0	2.0	2.0		2.0	3.0	1.0	X
26b	McClusky			0.0*	0.0	0.0	0.0	2.0	2.0		2.0	4.0	1.0	X
27	Valley City	4.0	1.0*	0.0	3.0	4.0	3.0*	2.0	3.0		2.0	3.0	2.0	X
28	Wahpeton	4.0	2.0	0.0	3.0	5.0	5.0*	3.0	6.0		3.0	3.0	2.0	X
29	Lake Darling	3.0	2.0	0.0	1.0*			2.0	2.0		2.0	3.0	1.0	X
30	Williston	2.0	3.0	0.0	2.0	3.0	3.0*	2.0	2.0		2.0	3.0	2.0	X
	SOUTH DAKOTA													
1	Black Hills National Forest	1.0	1.0	2.0	1.0*	1.0	0.0	1.0	1.0					X
2	Sioux Falls	5.0*		4.0	5.0	3.0	3.0	4.0	4.0*					X
3	Pierre													X
4	Newell													X
5	Hot Springs													X
6	Lemmon													X

(Continued)

TABLE 4. (CONTINUED)

SULFATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	UTAH													
1	Escalante								0.0*	0.0*	2.0	2.0*	2.0*	X
2	Henrieville								1.0*		4.0*			X
3	Glen Canyon City									2.0	2.0	3.0*	1.0*	X
4	Kearns	8.0	4.0											
5	Magna	23.0	6.0											
6	Ogden	1.0*	2.0	5.0	8.0			2.0*	8.0*					X
7	Salt Lake City	6.0	3.0											
8	Navajo Mountain									1.0	2.0	1.0*	3.0*	X
9	Oljato								3.0*	1.0	3.0	2.0*	3.0*	X
10	Aneth									2.0*	2.0	2.0*	2.0*	X
11	Bloomington								1.0*		3.0	3.0	2.0*	X
12	St. George								1.0*	3.0*	3.0	2.0	2.0*	X
13	Ogden	5.0	2.0											
14	Vernal													X
15	Price													X
16	Mills													X
17	Lyndyl													X
18	Green River													X
19	Moab													X
20	Emery													X
21	Huntington													X
22	Bryce Canyon National Park													X
	WYOMING													
1	Casper	0.0*	2.0	3.0	3.0									
2	Cheyenne		3.0	3.0	1.0			2.0*	2.0					X
3	Yellowstone National Park	2.0*	1.0	1.0	1.0*			1.0	2.0					X
4	Cheyenne													X
5	Converse Co.													X
6	Riverton													X
7	Rock Springs													X
8	Granger													X
9	Douglas													X
10	Gillette													X
11	Newcastle													X
12	Buffalo													X
13	Lusk													X
14	Wheatland													X

(Continued)

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TABLE 4. (CONTINUED)

NITRATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	ARIZONA													
2	Teec Nos Pos									1.7*	1.2	1.5	0.1*	X
3	Redrock									0.5*	1.3	1.1	1.1*	X
6	Chandler	4.5												X
7	Douglas	1.0*	0.9	1.0	1.4	1.5	1.1	1.0*	0.8*					X
10	Kaibeto									0.5*	1.2	1.6	1.3*	X
11	Coppermine									0.6	1.8	3.6*	0.8*	X
12	Bodaway									1.2*	1.4*	2.0*	1.5*	X
13	Tsai Skizzi									0.8*	1.2	1.3		X
14	Tuba City									0.6*	1.2	1.3	0.7*	X
18	Glendale	4.6*	1.3	3.1	2.0	3.2	1.9	2.1	2.8	3.8	1.8			X
19	Grand Canyon	0.2*	1.0*	1.2*	0.5*	0.5	0.8	0.8*	0.4					X
22	Carefree	2.5	1.3	1.3	0.9	1.5	1.7	1.5						X
23	St. Johns	3.1	1.5	2.0	2.8	3.0	1.6	1.4						X
24	Guadalupe	3.6	1.2	1.8	3.4	3.9	1.4	1.6						X
25	Litchfield	4.2	2.2											X
26	Mesa	2.4	1.3	1.8	1.1	1.4	1.2	1.3	1.2	0.8	0.9			X
28	Moccasin										1.3	3.3*	0.3*	X
31	Bacabi								1.5*	0.7	1.4	1.2*	2.1*	X
34	Paradise Valley	3.4												X
35	Phoenix	3.1	2.3	3.0	3.1	2.9	3.0	2.9	2.8	1.9*	2.3			X
36	Lee's Ferry									1.3*	1.3	1.4*		X
37a	Phoenix	2.8	1.0	2.4	2.7	2.5	1.8	1.7	2.5	1.8	1.5			X
37b	Phoenix	6.5*												X
38a	Phoenix	4.0												X
38b	Phoenix	2.3	0.8	1.7	1.9	2.0	1.8	1.4	1.7	2.3	1.1			X
49a	Scottsdale	2.1	1.6	2.1	2.9	2.0	2.0	1.9	1.5	1.8	1.7			X
49b	Scottsdale	3.5	1.2	2.9	1.8	2.3	1.6	1.8	1.7	2.0	1.2			X
52	Sun City	4.8												X
54	Tucson	1.8	1.8	3.1	3.3	2.6	2.9	2.1	1.7					X
	COLORADO													
1	Red Mesa									1.1*	0.9	1.3*		X
2	Ignacio										1.0	1.0*		X
3	Towaoc									1.6*	1.2	1.3*	1.0*	X
4	Adams City												3.0	X
5	Sand Dunes N.M.												3.0	X
6	Brush												3.6	X
7	Colorado Springs												2.0	X

(Continued)

TABLE 4. (CONTINUED)

NITRATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	COLORADO (cont.)													
8	Cortez												1.4	X
9	Craig												0.9	X
10	Delta												1.8	X
12	Denver	2.5*	3.1	2.6	2.7									
13	Denver												6.0	X
14	Denver												2.6	X
15	Fort Collins												2.6	X
16	Glenwood Springs												1.1	X
17	Grand Junction												2.8	X
18	Greeley												3.5*	X
19	Gunnison												0.8	X
20	Walden												0.7	X
21	La Junta												1.4	X
22	Loveland												2.6	X
23	Mesa Verde N.P.	0.2*	0.5*	0.6	0.3	0.2	0.7*	0.1	0.0					X
24	Mesa Verde N.P.												0.6	X
25	Pueblo												1.9	X
26	Pueblo												1.6	X
27	Meeker												0.4	X
28	Rangely												1.2*	X
29	Steamboat Springs												1.6	X
30	Sterling												2.1	X
31	Johnstown												2.5	X
32	La Salle												3.9	X
33	Platteville												3.8	X
34	Erie												2.6	X
35	Loveland													X
	MONTANA													
7	Glacier N.P.	0.3*	0.3*	0.0	0.2	0.3	0.4	0.1*	0.2					X
8	Helena	0.8*	0.3*	0.6	0.9			0.6	1.0					X
9	Ft. Howes	0.3*	0.3*	0.3	0.2			0.1	0.0					X
10	Ashland	0.3	0.6*	0.4*	0.3*	0.4	0.4	0.2	0.1					X
11	Decker													X
12	Billings													X
13	Butte													X
14	Ekalaka													X

(Continued)

TABLE 4. (CONTINUED)

NITRATE (microgram/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	MONTANA (cont.)													
15	Lindsay													X
16	Lindsay													X
17	Helena													X
18	Helena													X
19	Poplar													X
20	Colstrip													X
	NEW MEXICO													
1	Dulce									0.6*	0.7	1.0	0.2*	X
2	Huerfano									1.1*	1.2*	1.5*	0.7*	X
3	Chaco Canyon N.M.									1.0*	1.1	1.2*	0.7*	X
4	Burnham									0.6*	1.4*	1.2*		X
5	Albuquerque	1.8*	1.0	2.2*	3.4*	1.2*	1.6	1.9*	2.3	1.7*	1.8*			X
	NORTH DAKOTA													
1a	Maryvale	3.8	4.3	0.9*	2.1	2.6	1.5*							
1b	Valley City							1.3	1.5		1.5	1.4	1.2	X
2	Medora			0.0*	0.0	0.0	0.0	1.1	0.7		0.8	0.7	0.7	X
3a	Bismarck	2.0*	1.0	1.7	2.3	1.6	2.0	1.5	2.1		2.0	1.3	1.2	X
3b	Bismarck	2.8	1.1	1.2	0.8	1.0	1.7	1.8	1.6		1.4	1.0	1.2	X
4	Bowman			0.0*	0.0	0.0	0.0	0.9	0.9		0.6	0.7	0.6	X
5	Bismarck										0.9	0.9	0.9	X
6a	Fargo	3.2	0.6	0.4	0.8	1.8	2.2*	1.6	1.7		1.5	1.2	1.5	X
6b	Fargo	6.1	1.0	0.6	1.5	4.0	4.0*	1.9	2.2		1.5	1.4	2.3	X
6c	Fargo	4.7	1.2	0.6	1.8	3.9	3.0*	1.8	2.8		1.4	1.5	1.8	X
7	Devils Lake	1.7	0.6	0.8	1.4	1.3	1.4*	1.5	3.5*		1.7		2.1	X
8a	Dickinson	1.2	1.0	0.9	1.0	1.0	2.4*	1.4	1.3		1.2	1.1	0.7	X
8b	Dickinson				0.3*	0.7	1.6*	1.1	1.1		0.8	0.8	0.7	X
9	Mandaree							0.2*	1.2		0.9	0.7	0.8	X
10	Halliday								1.0		0.8	0.5	0.5	X
11a	Grand Forks	2.8	1.2	0.4	0.5*	2.9	2.1*	1.4	1.7		2.0	1.4	1.6	X
11b	Grand Forks		1.7	0.2	1.0	2.3*	1.8*	1.5	2.0		1.5	1.2	1.8	X
12	Glen Ullin							0.8	1.0		1.0	1.2	0.9	X
13	Mott			0.0*	0.0	0.0	0.0	0.9	1.1		0.9	0.8	1.0	X
14	New England							0.9*	0.7		0.9	0.9	0.6	X
15a	Jamestown	2.5	0.8*	1.0	1.4	1.4	1.3*	1.2	1.1		1.4	1.0	0.9	X

(Continued)

TABLE 4. (CONTINUED)

NITRATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	NORTH DAKOTA (cont.)													
15b	Jamestown	2.4	1.1	0.4	0.8	1.1	1.0*	1.5	1.2		1.8	1.4	0.9	X
16	Grassy Butte							0.2*	0.9		0.8	0.7	0.8	X
17	Garrison			0.0*	0.0	0.0	0.0	1.2	1.2		0.8	0.8	1.3	X
18	Washburn			0.0*	0.0	0.0	0.0	1.1	1.3		1.0	1.2	0.6	X
19	Mandan	1.3	0.6	0.4	0.9	2.1	2.3	1.5	1.7		1.5	1.5	1.1	X
20	Beulah	1.7	1.1	0.8	1.4	1.2	1.7	1.0	1.7		0.8	0.7	0.9	X
21	Beulah	1.6	1.4	0.4	0.8		1.1	1.1	1.5		0.9	0.8	0.6	X
22	Minot	1.4	0.0*	0.6*	1.4	2.9		0.9*			1.2	0.8*	1.2	X
23	New Salem							0.7*	1.3		0.9	0.8	0.8	X
24	Parshall			0.0*	0.0	0.0	0.0	1.0	2.1		0.8	0.8	1.0	X
25	Stanton			0.0*	0.0	0.0	0.0	1.2	1.4		1.0	1.0	0.9	X
26a	McClusky			0.0*	0.0	0.0	0.0	0.9	1.1		0.9	1.0	1.1	X
26b	McClusky			0.0*	0.0	0.0	0.0	1.1	1.3		0.8	0.9	0.9	X
27	Valley City	2.7	0.6*	0.7	1.4	1.7	1.5*	0.8	1.5		1.9	1.1	1.4	X
28	Wahpeton	5.6	1.1	1.2	2.9	3.0	1.5*	1.4	2.1		2.8	1.6	1.7	X
29	Lake Darling	2.2	0.9	0.3	0.5*			0.6	0.9		0.4	0.9	0.8	X
30	Williston	1.3	0.4	0.7	1.3	1.8	1.3*	1.1	1.1		1.5	0.7	1.0	X
	SOUTH DAKOTA													
1	Black Hills National Forest	0.1	0.6	0.6	0.3*	0.3	0.2	0.2	0.0					
2	Sioux Falls	1.6*		2.7	4.4	2.0	1.9	1.7	2.8*					X
3	Pierre													X
4	Newell													X
5	Hot Springs													X
6	Lemmon													X
	UTAH													
1	Escalante								0.9*	0.4*	0.8	1.1*	1.1*	X
2	Henrieville								0.6*		0.8*			X
3	Glen Canyon City									0.9	1.1	1.2*	0.2	X
4	Kearns	4.7	1.4											
5	Magna	5.2	0.9											
6	Odgen	0.8*	1.3	2.8	7.4			1.6*	6.8*					X
7	Salt Lake City	4.8	1.6											
8	Navajo Mountain									0.8	1.2	1.1*	1.8*	X
9	Oljato								2.5*	1.0	1.2	1.3*	1.4*	X
10	Aneth									1.2*	1.0	1.2*	1.0*	X

(Continued)

TABLE 4. (CONTINUED)

NITRATE (micrograms/cubic meter)

CODE	STATION	1975 I	1975 II	1975 III	1975 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1978**
	UTAH (cont.)													
11	Bloomington								0.4*		1.5	2.0	1.1*	X
12	St. George								1.1*	1.0	1.8	2.2	3.0*	X
13	Odgen	5.5	1.4											
14	Vernal													X
15	Price													X
16	Hills													X
17	Lyndyl													X
18	Green River													X
19	Moab													X
20	Emery													X
21	Huntington													X
22	Bryce Canyon National Park													X
	WYOMING													
1	Casper	0.8*	0.5	1.0	0.4									
2	Cheyenne		0.7	1.3	0.9			2.2*	0.9					X
3	Yellowstone N.P.	0.2*	0.5	0.4	0.3*			0.2	0.8					X
4	Cheyenne													X
5	Converse Co													X
6	Riverton													X
7	Rock Springs													X
8	Granger													X
9	Douglas													X
10	Gillette													X
11	Newcastle													X
12	Buffalo													X
13	Lusk													X
14	Wheatland													X

* Mean does not meet SAROAD Summarization Criteria
** Projected 1978 Activity

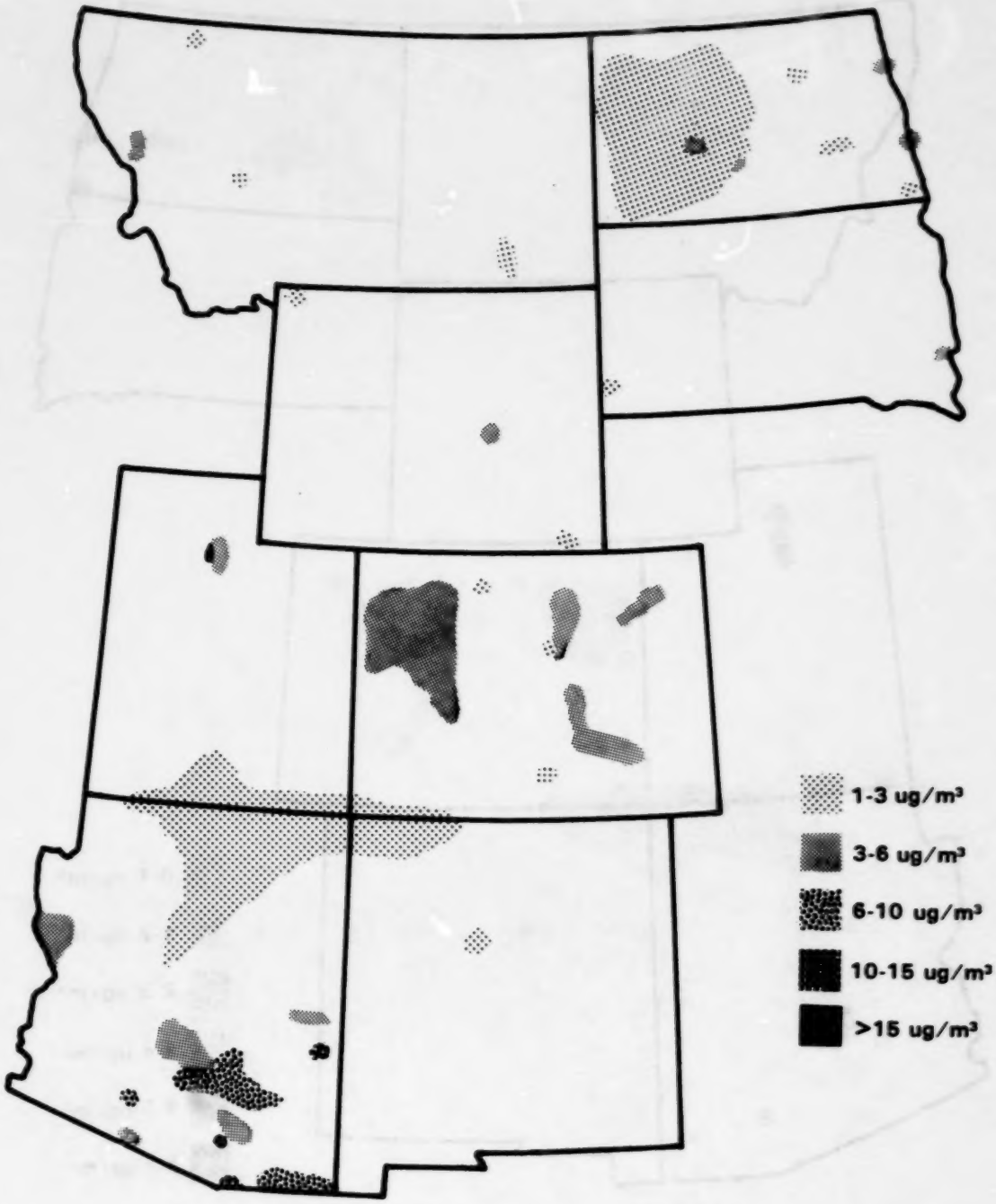

Figure 5. Regional composite map of sulfate concentrations, 1975-1977

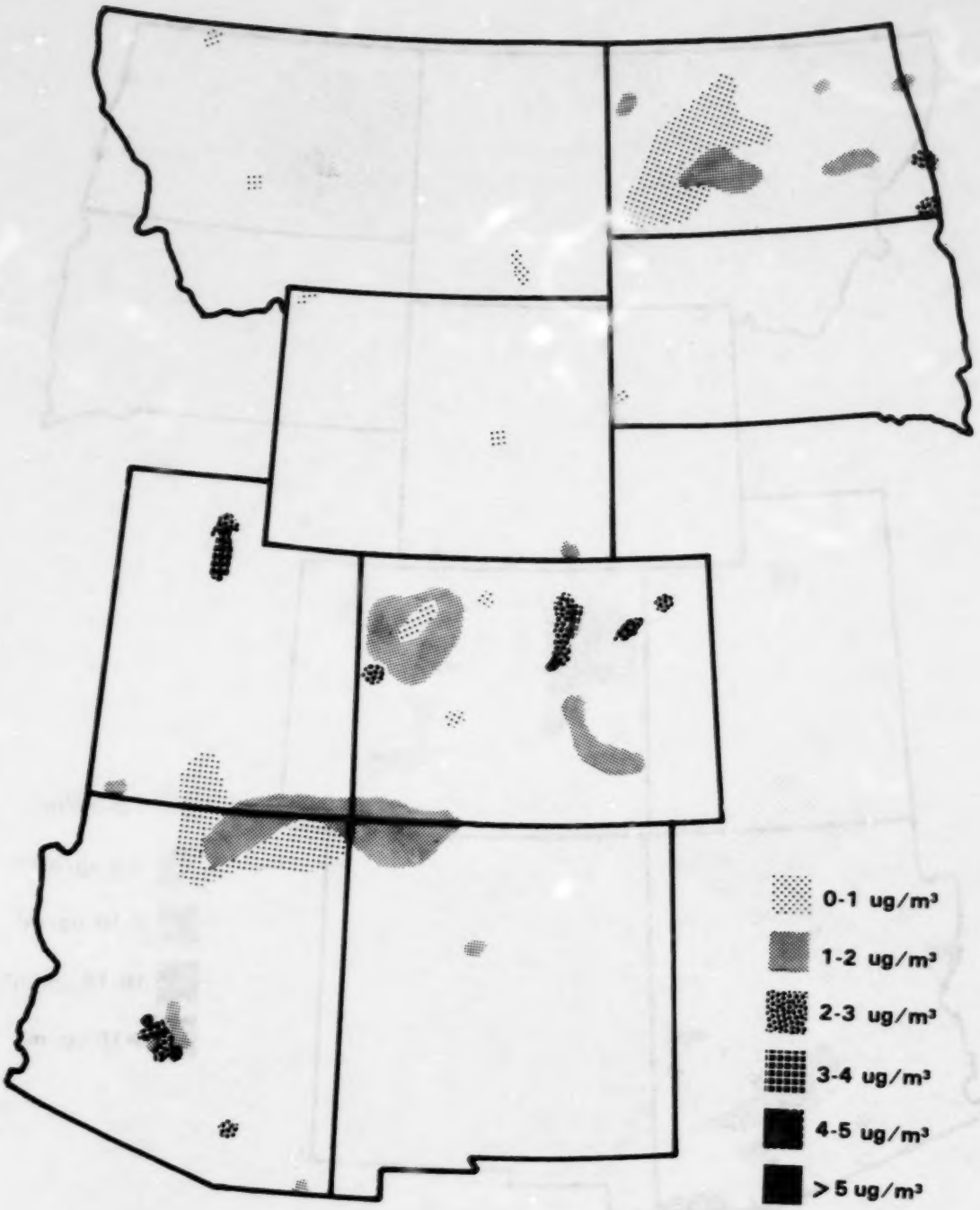

Figure 6. Regional composite map of nitrate concentrations, 1975-1977

to 50% are most likely. However, as can be seen in Table 3 errors in excess of 100% have occurred and could significantly alter the regional comparisons.

At this time, the data do not provide adequate regional coverage. However, projections for 1978 suggest considerable improvement in data coverage. The addition of data in Wyoming, and the expansion of sulfate analysis in Montana, Utah, and Arizona should provide the data base needed for detailed regional analysis. A continuation of this data reporting for 2 to 3 years should also provide sufficient data to assess regional trends in the WERDA.

REFERENCES

1. Charlson, R. J., A. P. Waggoner, J. F. Thielke, Visibility Protection for Class I Areas: The Technical Basis. (Publication Pending) April, 1978.

2. Environmental Protection Agency, Position Paper on Regulation of Atmospheric Sulfates, EPA-450/2-75-007, September, 1975.

3. Greeley, R. S., R. P. Ouellette, J. T. Stone, S. Wilcox, Sulfates and the Environment - A Review, Mitre Corporation MTR-6895. March, 1975.

APPENDIX A

STATION LISTS AND MAPS

Appendix A has been provided to facilitate the location of each station referenced in the report. The first portion of this appendix lists the station codes used in this report along with their corresponding station names and SAROAD numbers. The map coordinates provided in column 4 can be used to locate the station on the state maps following this list. Additional information on the individual stations is available from the National Aerometric Data Base using the SAROAD system.

CODE	STATION	SAROAD ID.	MAP COORDINATE
	ARIZONA		
1	Ajo	030020001	F2
2	Teec Nos Pos	030040001	A6
3	Redrock	030040003	A6
4	Eager	030040005	D6
5	Casa Grande	030100001	E4
6	Chandler	030120001	E3
7a	Douglas	030180003	G6
7b	Douglas	030180004	G6
7c	Douglas	030240004	G6
8	Paul Spur	030180005	G6
9	Page	030200004	A4
10	Kaibeto	030200010	A4
11	Coppermine	030200011	A4
12	Bodaway	030200012	A4
13	Tsai Skizzi	030200013	A5
14	Tuba City	030200014	B4
15	Flagstaff	030280001	C4
16a	Hayden	030300001	E5
16b	Hayden	030300901	E5
17a	Miami	030300003	E5
17b	Miami	030480902	E5
18	Glendale	030320001	E3
19	Grand Canyon National Park	030370001	B3
20	Morenci	030380001	E6
21	Kingman	030420001	C1
22	Carefree	030440006	D3
23	St. Johns	030440007	E3
24	Guadalupe	030440008	E3
25	Litchfield	030440009	E3
26	Mesa	030460002	E4
27	Davis Dam	030500006	B1
28	Moccasin	030500009	A3
29	Lake Havasu	030500013	C1
30	Mineral Park	030500014	B1
31	Bacabi	030520003	B5
32	Show Low	030520007	D5
33a	Nogales	030540002	G4
33b	Nogales	030540003	G4
34	Paradise Valley	030570002	E3
35	Phoenix	030600002	E3
36	Lee's Ferry	030200007	A4
37a	Phoenix	030600004	E3
37b	Phoenix	030600010	E3

CODE	STATION	SAROAD ID.	MAP COORDINATE
37c	Phoenix	030600014	E3
38a	Phoenix	030600011	E3
38b	Phoenix	030600013	E3
39	Organ Pipe National Monument	030620005	G3
40	Green Valley	030620007	G4
41	Rillito	030620009	F4
42	Rillito	030620010	F4
43	Tucson	030620011	F4
44a	Twin Buttes	030620015	G4
44b	Twin Buttes	030620016	G4
45	Florence	030640001	E4
46	San Manuel	030640003	F5
47	Prescott	030660001	C3
48	Safford	030680001	F6
49a	Scottsdale	030740003	E3
49b	Scottsdale	030740004	E3
50	Sierra Vista	030760001	G5
51	South Tucson	030780001	F4
52	Sun City	030790002	E3
53	Superior	030800003	E4
54a	Tucson	030860001	F4
54b	Tucson	030860002	F4
54c	Tucson	030860009	F4
54d	Tucson	030860012	F4
55a	Tucson	030860007	F5
55b	Tucson	030860008	F5
56	Tucson	030860013	G5
	COLORADO		
1	Red Mesa	061300002	G2
2	Ignacio	061300003	G3
3	Towaoc	061600004	G1
4	Adams City	060020001	B6
5	Sand Dunes N. M.	060060001	F5
6	Brush	060280001	B8
7	Colorado Springs	060380004	D6
8	Cortez	060440002	G1
9	Craig	060480001	A3
10	Delta	060540001	D2
11	Denver	060580001	C6
12	Denver	060580002	C6
13	Denver (Gates Rubber)	060580003	C6
14	Denver (CARIH)	060580009	C6
15	Fort Collins	060820001	A6
16	Glenwood Springs	060920001	C3

CODE	STATION	SAROAD ID.	MAP COORDINATE
17	Grand Junction	060980010	D1
18	Greeley	061000006	B6
19	Gunnison	061020001	E4
20	Walden	061120002	A4
21	La Junta	061220001	F8
22	Loveland	061480002	B6
23	Mesa Verde N. P.	061530002	G1
24	Mesa Verde N. P.	061530003	G1
25	Pueblo	061820001	E7
26	Pueblo	061820003	E7
27	Meeker	061860001	B2
28	Rangely	061860002	B1
29	Steamboat Springs	061920003	B3
30	Sterling	062080001	A8
31	Johnstown	062220003	B6
32	La Salle	062220004	B6
33	Platteville	062220005	B6
34	Erie	062220006	B6
35	Loveland	061220002	B6
	MONTANA		
1	Missoula	271100001	C2
2	Missoula	271100009	C2
3	Missoula	271100016	C2
4	Missoula	271100017	C2
5	Missoula	271100015	C2
6	Frenchtown	271100014	C2
7	Glacier National Park	270570001	A3
8	Helena	270720001	D4
9	Ft. Howes	271240008	E9
10	Ashland	271360026	E9
11	Decker	270060009	F9
12	Billings	270080006	E7
13	Butte	270160005	E4
14	Ekalaka	270200002	D11
15	Lindsay	270360002	C10
16	Lindsay	270360003	C10
17	Helena	270760903	D4
18	Helena	270860002	D4
19	Poplar	271340001	B10
20	Colstrip	271360027	E9
	NEW MEXICO		
1	Dulce	320920003	A3
2	Huerfano	321000007	B2
3	Chaco Canyon N.M.	321000011	B2

CODE	STATION	SAROAD ID.	MAP COORDINATE
4	Burnham	321000012	B2
5	Albuquerque	320040001	D4
	NORTH DAKOTA		
1a	Maryvale	350040001	D8
1b	Valley City	350040002	D8
2	Medora	350080001	D1
3a	Bismarck	350100001	E5
3b	Bismarck	350100002	E5
4	Bowman	350160001	E1
5	Bismarck	350200001	E5
6a	Fargo	350220001	E10
6b	Fargo	350400001	E10
6c	Fargo	350400002	E10
7	Devils Lake	350260001	B7
8a	Dickinson	350300001	D2
8b	Dickinson	351140001	D2
9	Mandaree	350340001	D3
10	Halliday	350340002	D3
11a	Grand Forks	350480001	C10
11b	Grand Forks	350480002	C10
12	Glen Ullin	350520001	E4
13	Mott	350560001	E3
14	New England	350560002	E2
15a	Jamestown	350580001	E7
15b	Jamestown	351180001	E7
16	Grassy Butte	350700001	D2
17	Garrison	350720001	C4
18	Washburn	350720002	D5
19	Mandan	350740001	E5
20	Beulah	350760001	D4
21	Beulah	350760002	D4
22	Minot	350780001	B4
23	New Salem	350800001	E4
24	Parshall	350820001	C3
25	Stanton	350860001	D4
26a	McClusky	351060001	D5
26b	McClusky	351060002	D5
27	Valley City	351240001	E8
28	Wahpeton	351260001	F10
29	Lake Darling	351300001	B4
30	Williston	351360001	B1
	SOUTH DAKOTA		
1	Black Hills National Forest	430110001	E1

CODE	STATION	SAROAD ID.	MAP COORDINATE
2	Sioux Falls	431480001	E11
3	Pierre	431340001	C6
4	Newell	430240001	C2
5	Hot Springs	430780001	E1
6	Lemmon	431320001	A3
	UTAH		
1	Escalante	460300002	H4
2	Henrieville	460300003	H3
3	Glen Canyon City	460400003	I4
4	Kearns	460440001	C3
5	Magna	460520001	C3
6	Ogden	460680001	B4
7	Salt Lake City	460920001	C4
8	Navajo Mt.	460960001	I5
9	Oljato	460960002	I6
10	Aneth	460960003	I7
11	Bloomington	461280001	I1
12	St. George	461280002	I1
13	Ogden	460680004	B4
14	Vernal	461200001	C6
15	Price		E5
16	Mills		E3
17	Lyndyl		E3
18	Green River		F6
19	Moab		F7
20	Emery	460280004	F4
21	Huntington	460140001	E5
22	Bryce Canyon National Park	460300001	H3
	WYOMING		
1	Casper	520120001	D7
2a	Cheyenne	520140001	G8
2b	Cheyenne	520140001	G8
3	Yellowstone National Park	520860001	A1
4	Converse Co.	520180001	D7
5	Riverton	520600001	D4
6	Rock Springs	520620001	F3
7	Granger	520700001	F2
8	Douglas	520180006	D8
9	Gillette	520080001	B8
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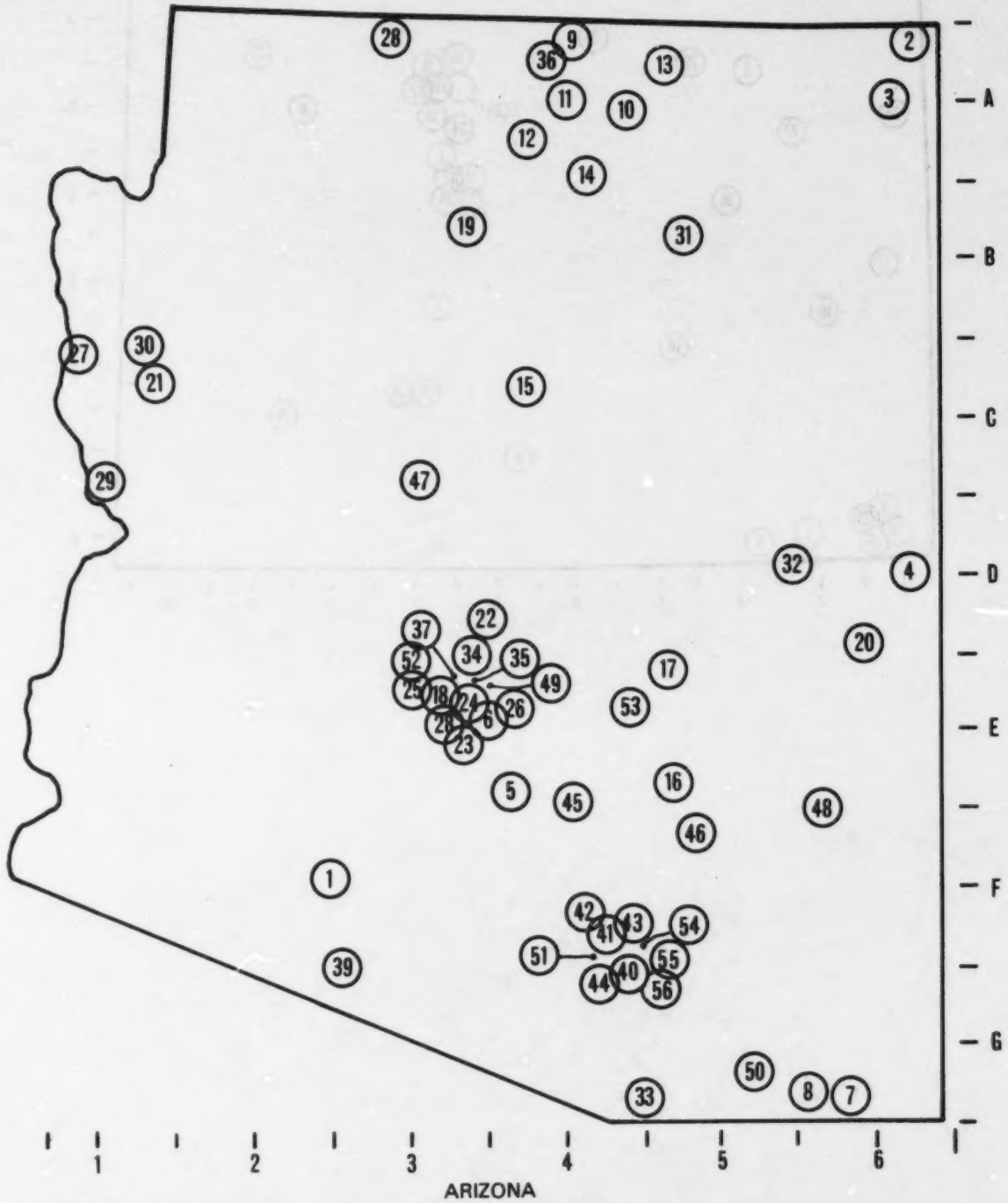
13	Wheatland	520540001	F8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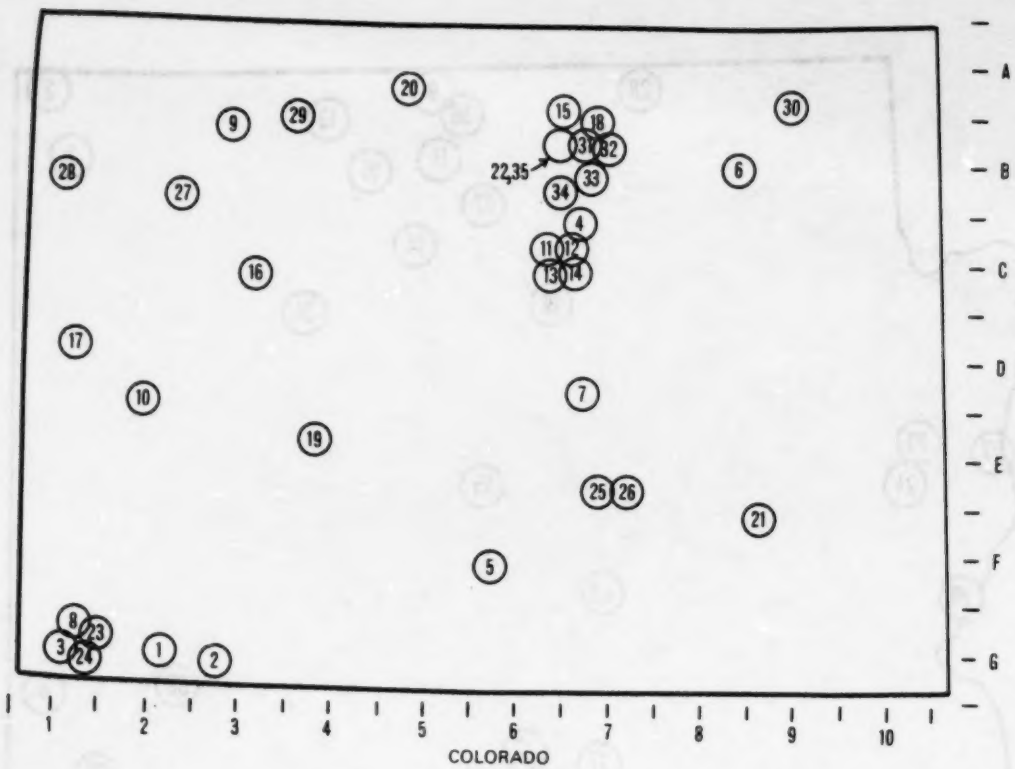
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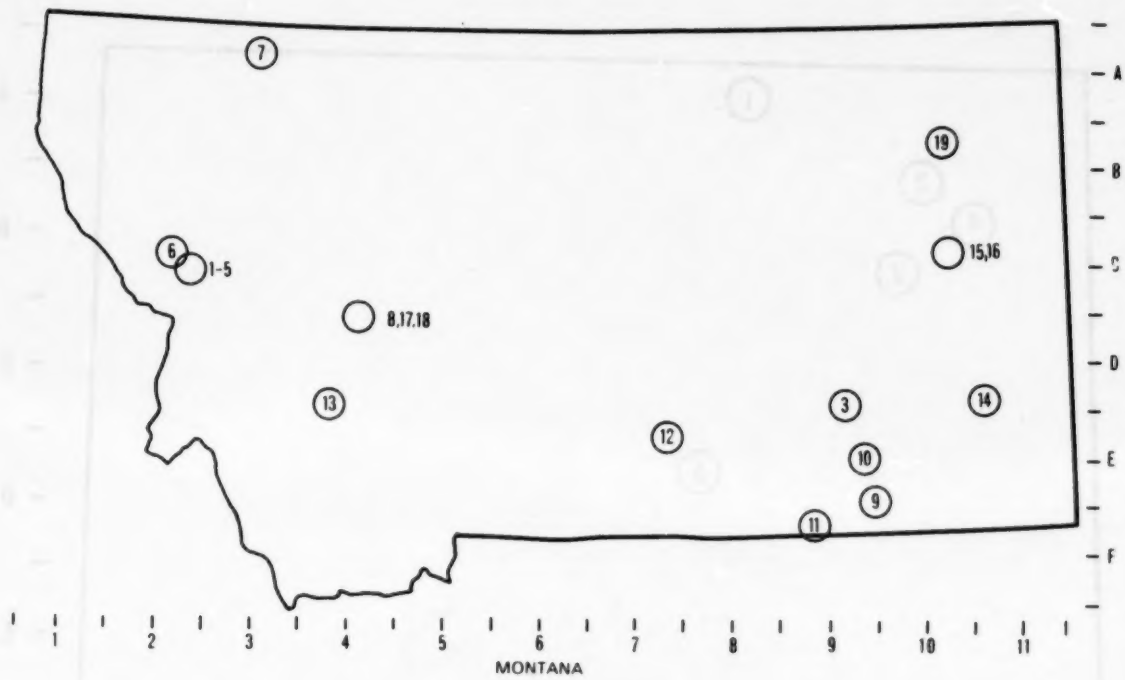
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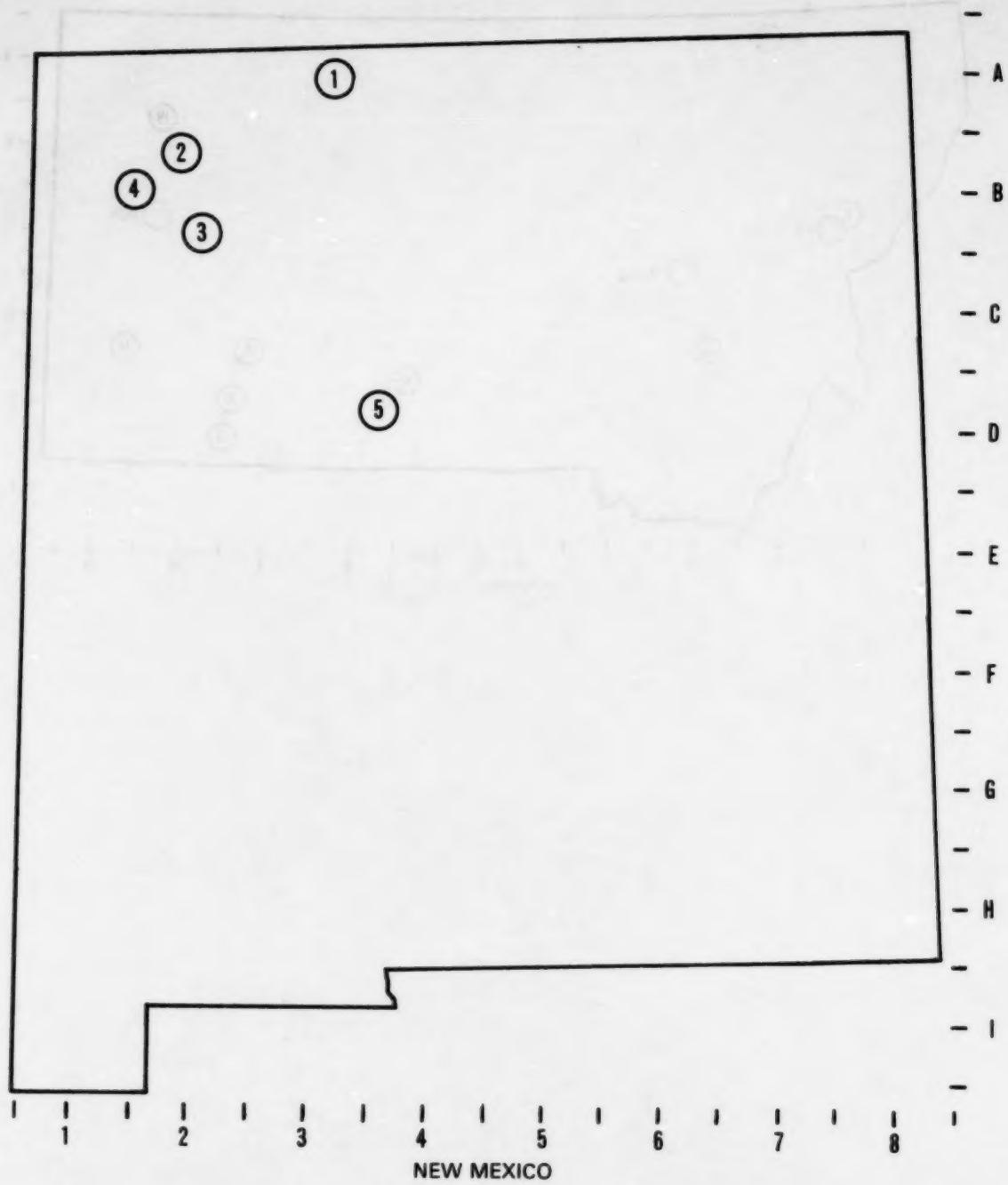

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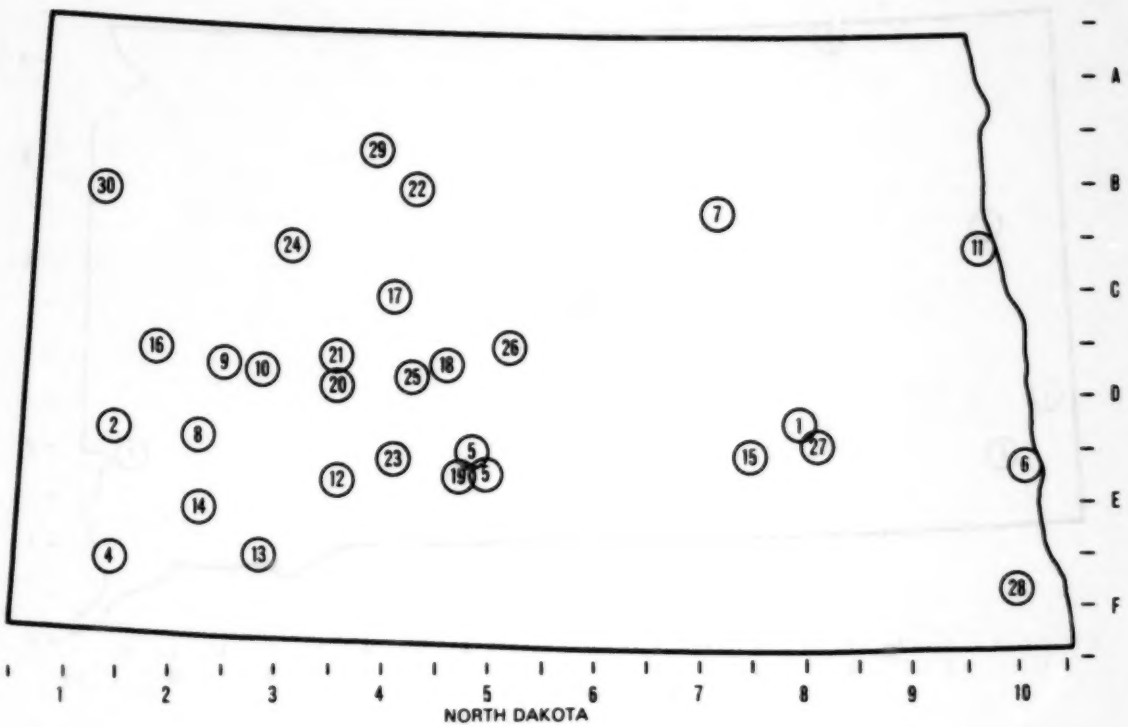
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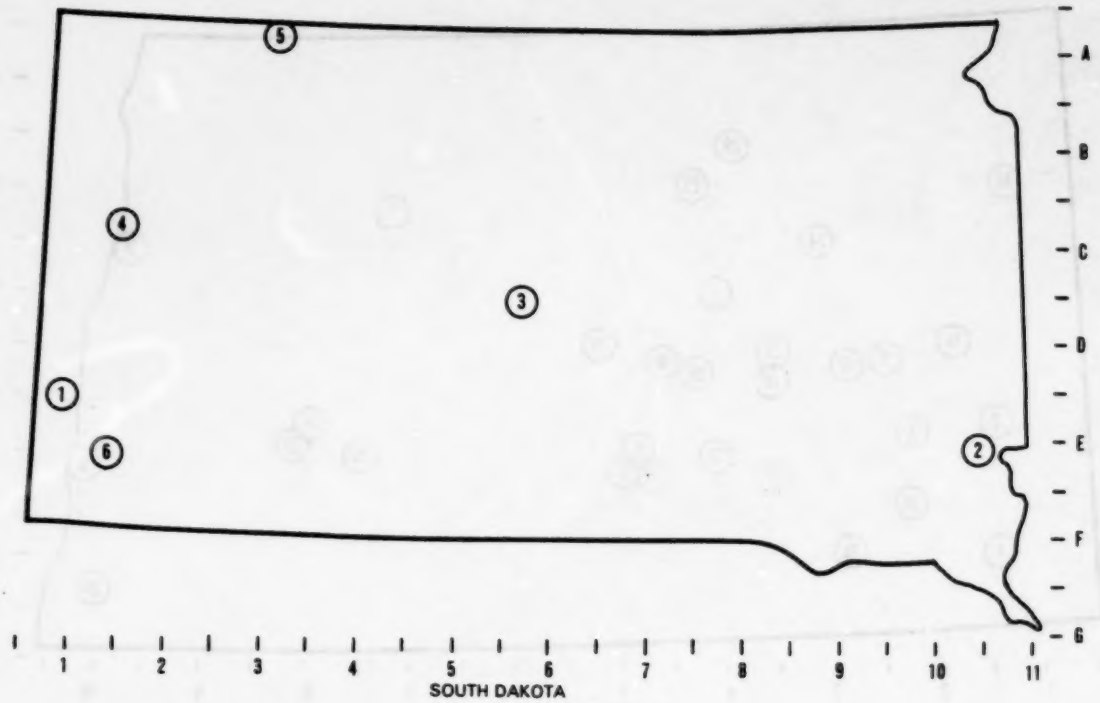
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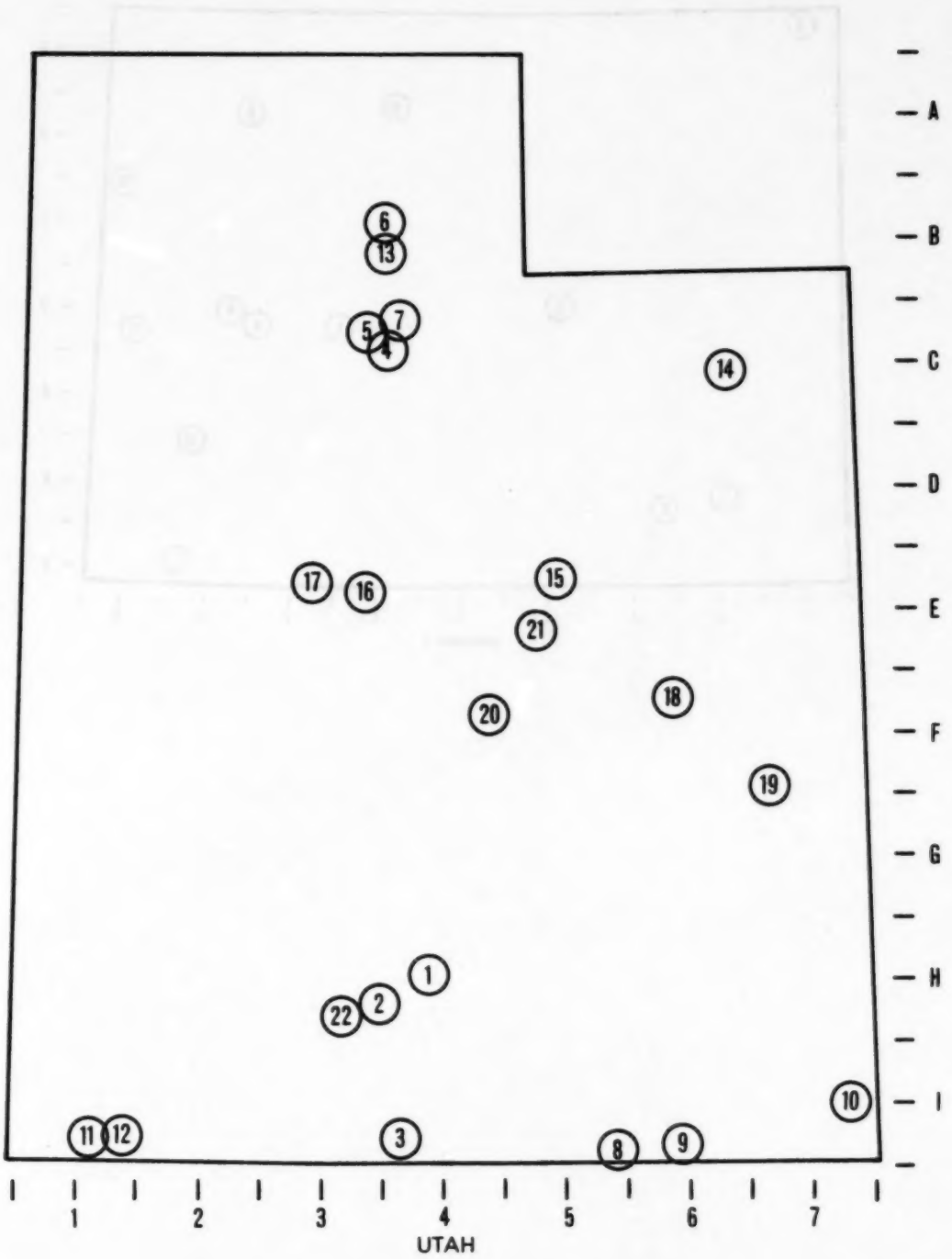
SOUTH DAKOTA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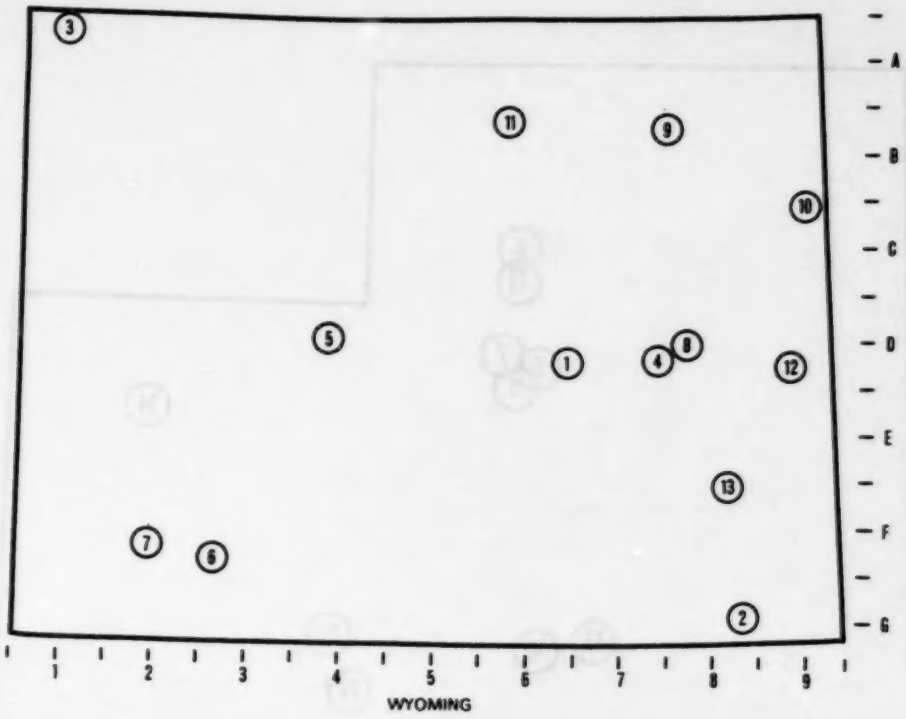
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WYOMING